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Spatial Patterns of Air Toxins in the Region

by Vivek Shandas and Linda George

Studies from England to Boston to Los Angeles have long documented health impacts associated with dirty air, but an increasing number of researchers are connecting air quality with urban form and human health. A recent landmark study found that children living near high-traffic areas in Los Angeles suffered long-term damage to lung tissue and contracted respiratory illnesses.

Ironically, while each breath we take is a product of the air quality in our immediate surroundings, few studies have described how the quality of air varies within a single city. Air quality research usually focuses on isolated areas or large regional scales. These preferences are partly due to the fact that extensive monitoring of air quality is expensive, which makes it difficult to know what the conditions are for neighborhoods around a city.

All of this changed when the Oregon Department of Environmental Quality (DEQ) decided to undertake a highly technical modeling exercise. Known as the Portland Air Toxics Assessment (PATA), DEQ used land use, topographical, transportation, and meteorological data in the metroscape to identify the possible sources of air toxics emissions and wind patterns, and then modeled the resulting air quality for nearly 1,000 sites in the region (Figure 1). It is important to note that the points on Figure 1 do not represent actual monitored data, but a modeled prediction as to what could be going on in those locations. Monitoring throughout the city would be cost-prohibitive.

Thanks to the efforts of DEQ, the PATA study represents one of the highest resolution datasets of modeled air quality in the nation. Additional information about the methods used for creating the air pollution data can be found on DEQ's website (<http://www.deq.state.or.us/aq/toxics/pata.htm>). In essence, the study documents emission and dispersion of 12 urban air pollutants in the Portland area known to have toxic health effects.

This Atlas draws on the PATA study to explore the regional variation of air quality. The PATA study presents an extraordinary opportunity to think about how the creation of new information can help us better plan our cities, but it also challenges us to think about the impacts of the choices we make.

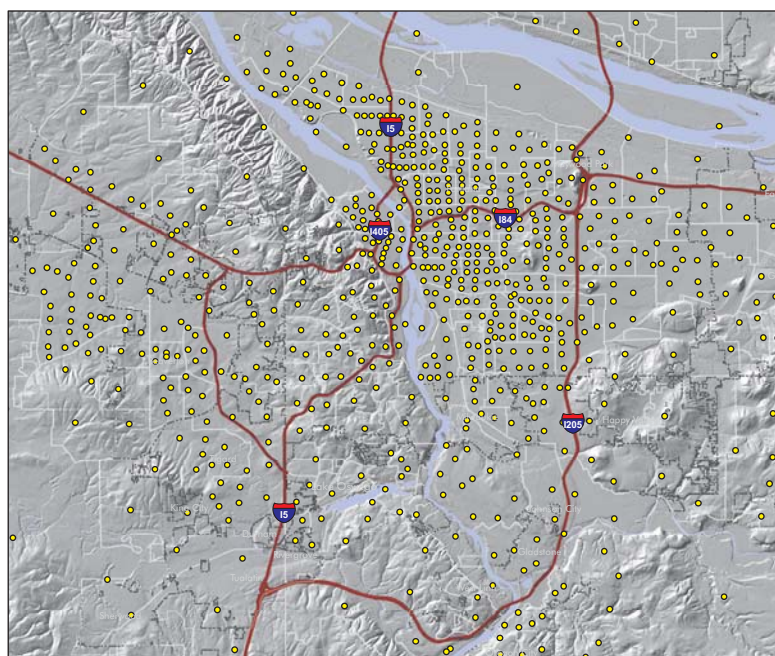


Figure 1

Air Quality

Using a series of spatial analysis techniques, we are able to take individual points of information and create a "layer" of information. The layer provides additional information by drawing on known air quality data and estimating air quality in areas for which no data exist. We use this process to create several maps of different pollutants for our region. Here, our objective is not to look at every pollutant in the PATA study, but to highlight a few pollutants that represent different activities in the metroscape. While the range of concentrations may vary, the protocol for determining concentrations remains the same. We have mapped the "relative cancer risk" associated with each compound (for the cumulative risk map we added the risks). Relative risk refers to how many times the modeled concentrations exceed the baseline risk. The baseline risk is 1 excess cancer in 1 million population due to lifetime exposure to a pollutant. One in a million is baseline level of concern for the EPA. For instance, a relative risk value of "6" predicts 6 excess cancers in a million population as a result of lifetime exposure to a pollutant. The values can be interpreted as the severity of impact associated to exposure to that compound at that location.

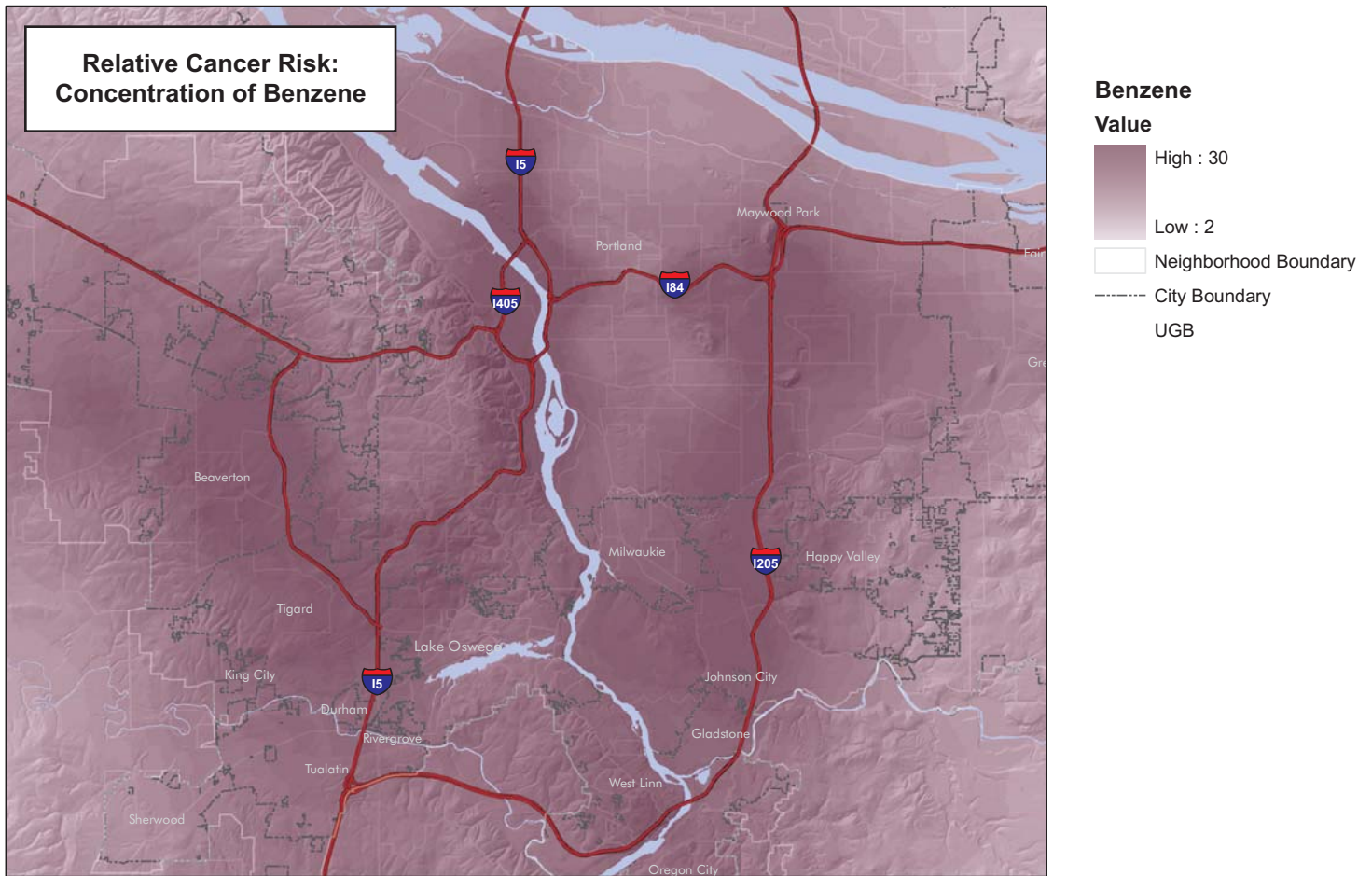


Figure 2

Source: DEQ

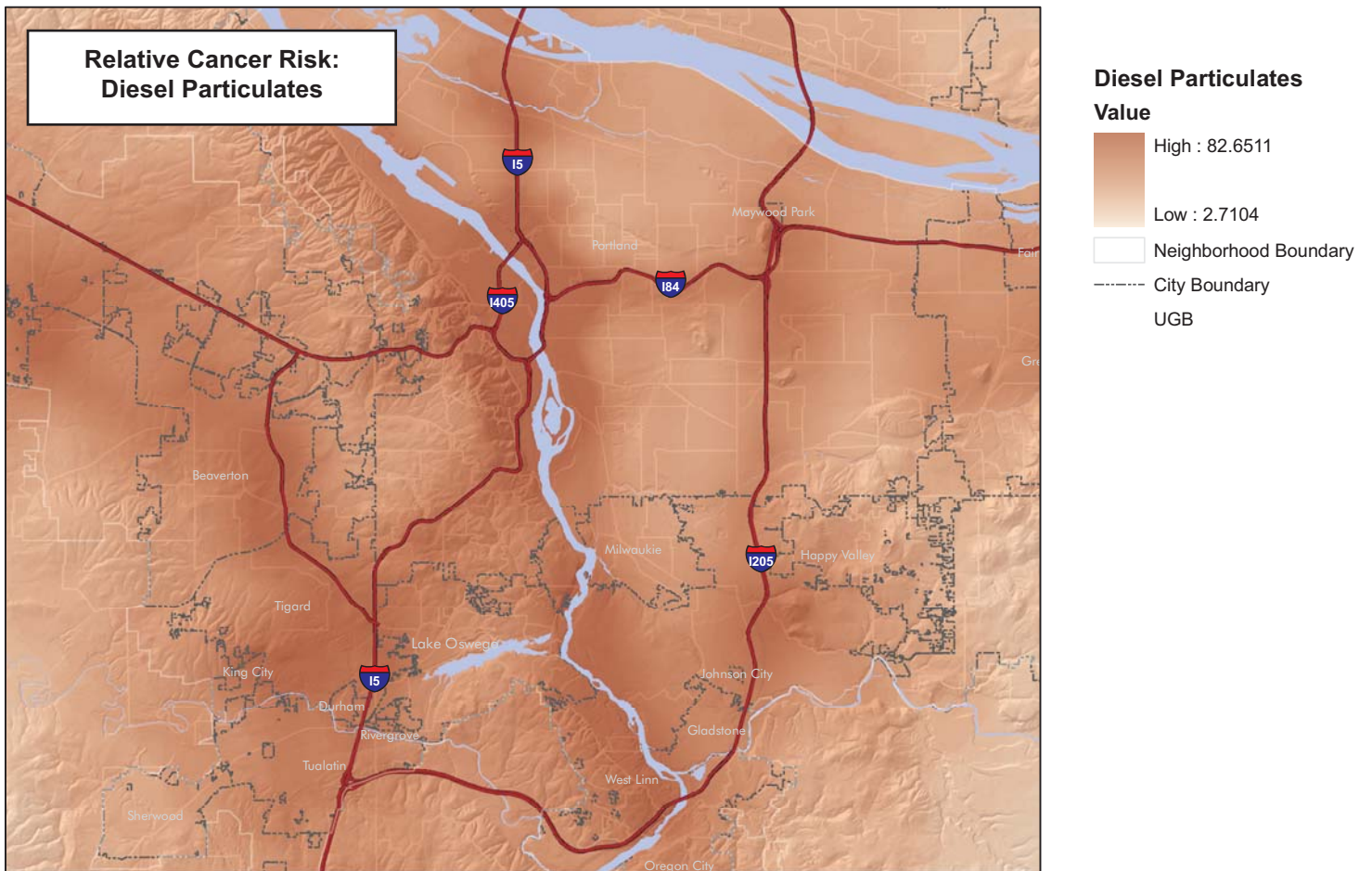


Figure 3

Source: DEQ

We begin by looking at mobile sources of air pollution. These are pollutants from cars, trucks, trains, and boats. One byproduct of burning fossil fuels is illustrated in Figure 2, which shows the variation in benzene concentrations for the region. As might be expected, the highest concentrations (darkest areas) are along highway corridors. A second byproduct is the creation of diesel particulate matter, tiny fragments of carbonaceous material that are created by burning diesel fuel (Figure 3). While both benzene and diesel come from internal combustion engines, one noticeable difference is the concentration of diesel along major truck routes, including interstates 84 and 5. Most boats also use diesel fuel, and this fact is represented along the Willamette River, which also serves as a major transportation corridor. The largest source of diesel particulate matter comes from non-road engines, such as construction equipment.

While mobile sources of air pollution tell one story about the driving and boating we do, stationary sources tell another. In this case we look specifically at Perchloroethylene (or 'Perc'), a toxic compound used in the U.S. since the 1940s in several industrial processes, including dry cleaning. Unlike mobile sources, concentrations of Perc do not follow freeway corridors, but discrete areas throughout the region (Figure 4). Often the high concentrations can be due to specific land uses that emit these compounds—in this case, probably dry cleaning facilities.

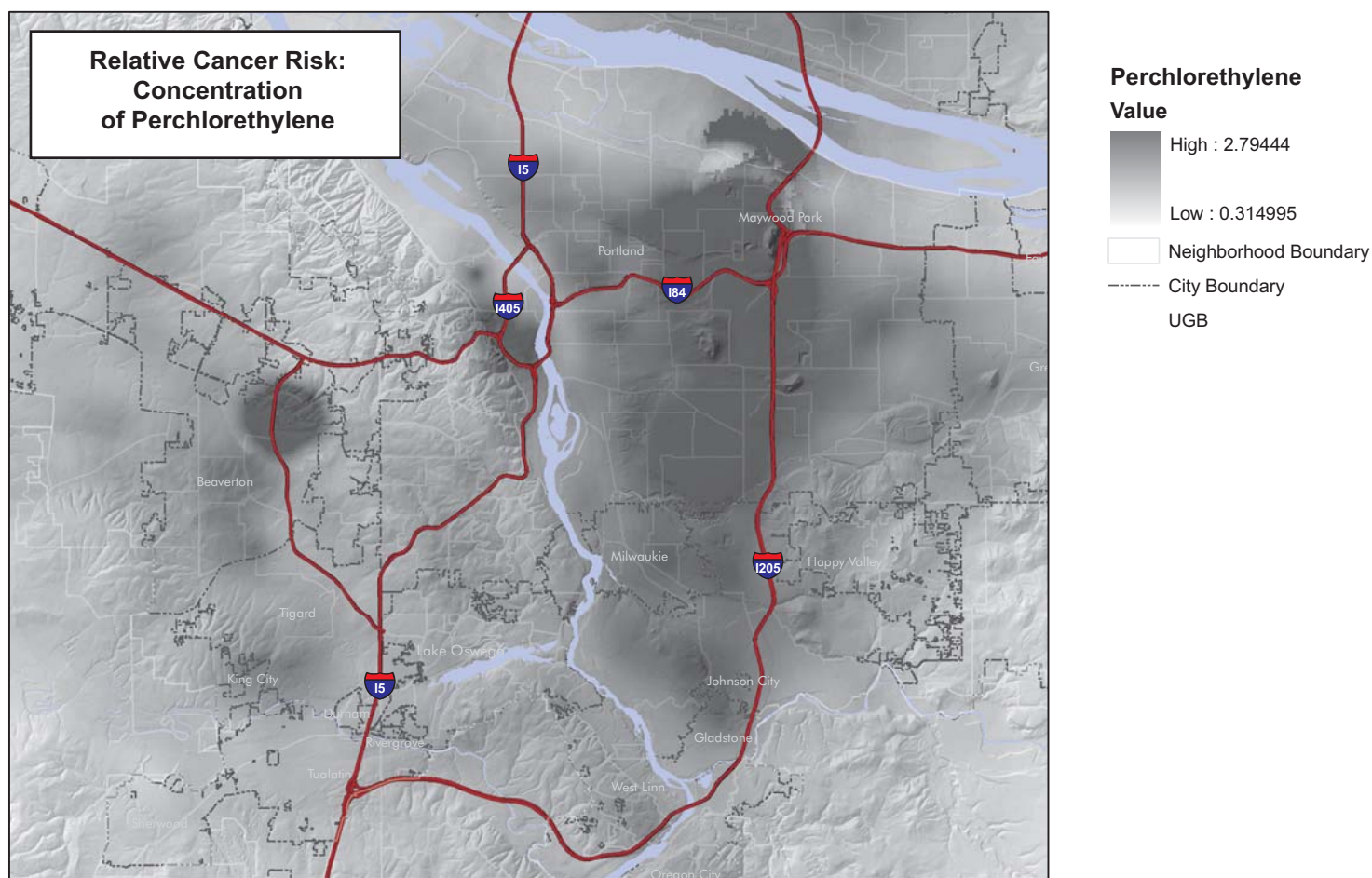


Figure 4

Source: DEQ

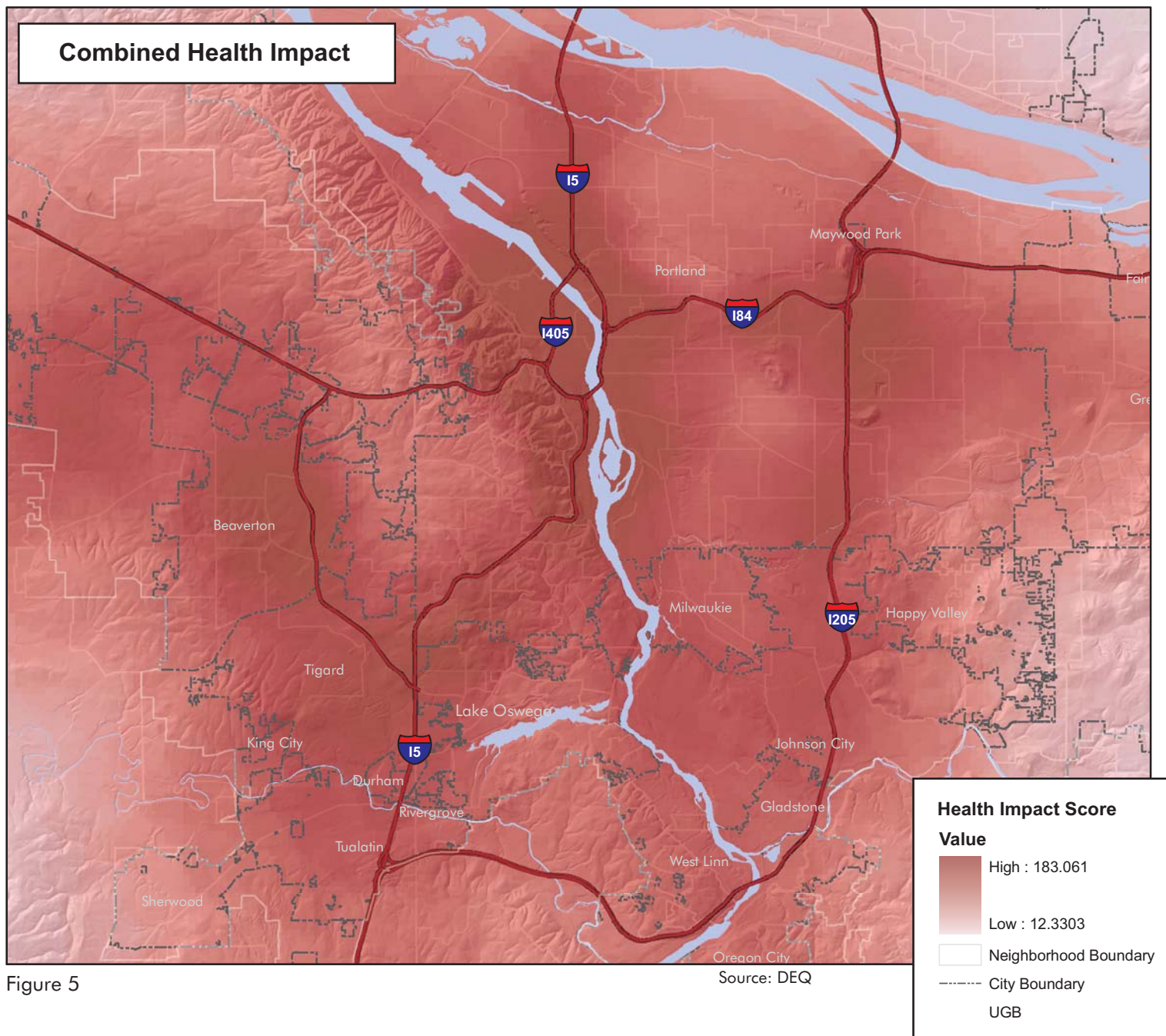


Figure 5

While these three examples provide a glimpse into specific concentrations of air pollutants in the metrocape, the PATA study contains eight other compounds, including chloroform, chromium, formaldehyde, nickel and others. When we add up all of these compounds, we can assess their combined concentration. Figure 5 illustrates an overall estimated health impact from these pollutants. While roadways seem to be the primary indicator for compromised air quality, the patterns vary considerably around the region. With a higher density of highways occurring in downtown Portland, it

may not be surprising that downtown has some of the highest concentrations of air pollutants; however, these trends are not confined only to downtown. In fact, Figure 6 illustrates that suburban areas such as those along Highway 217 near Beaverton, and at the interchange of interstates 84 and 205 near Gresham, are also affected by high concentrations of air pollutants. Unfortunately, one story emerging from these studies is that we cannot avoid air pollution by moving away from downtown areas. Spreading out seems to only bring the problem elsewhere.

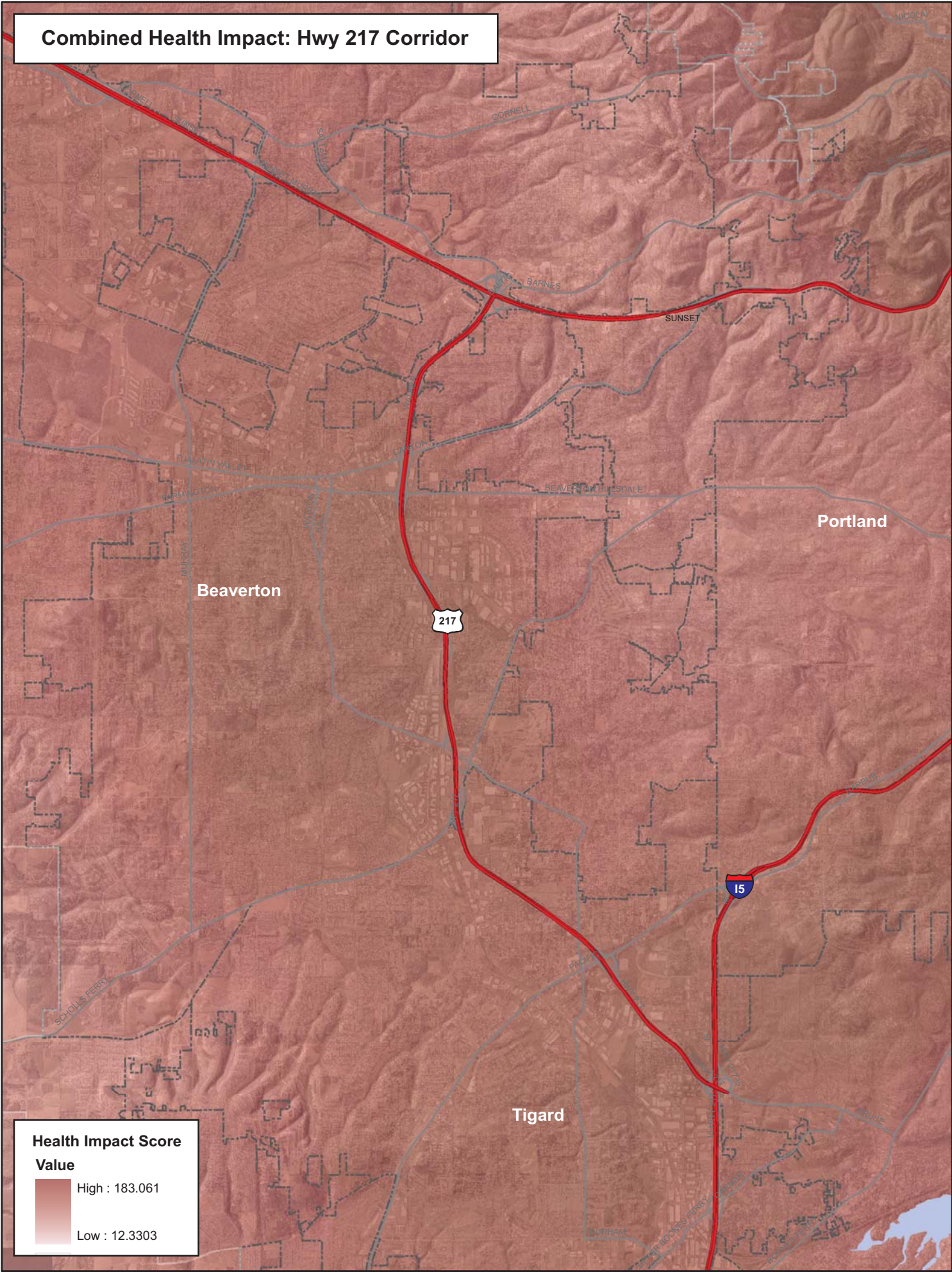


Figure 6

Source: DEQ

Traffic Volume and Air Quality Analysis

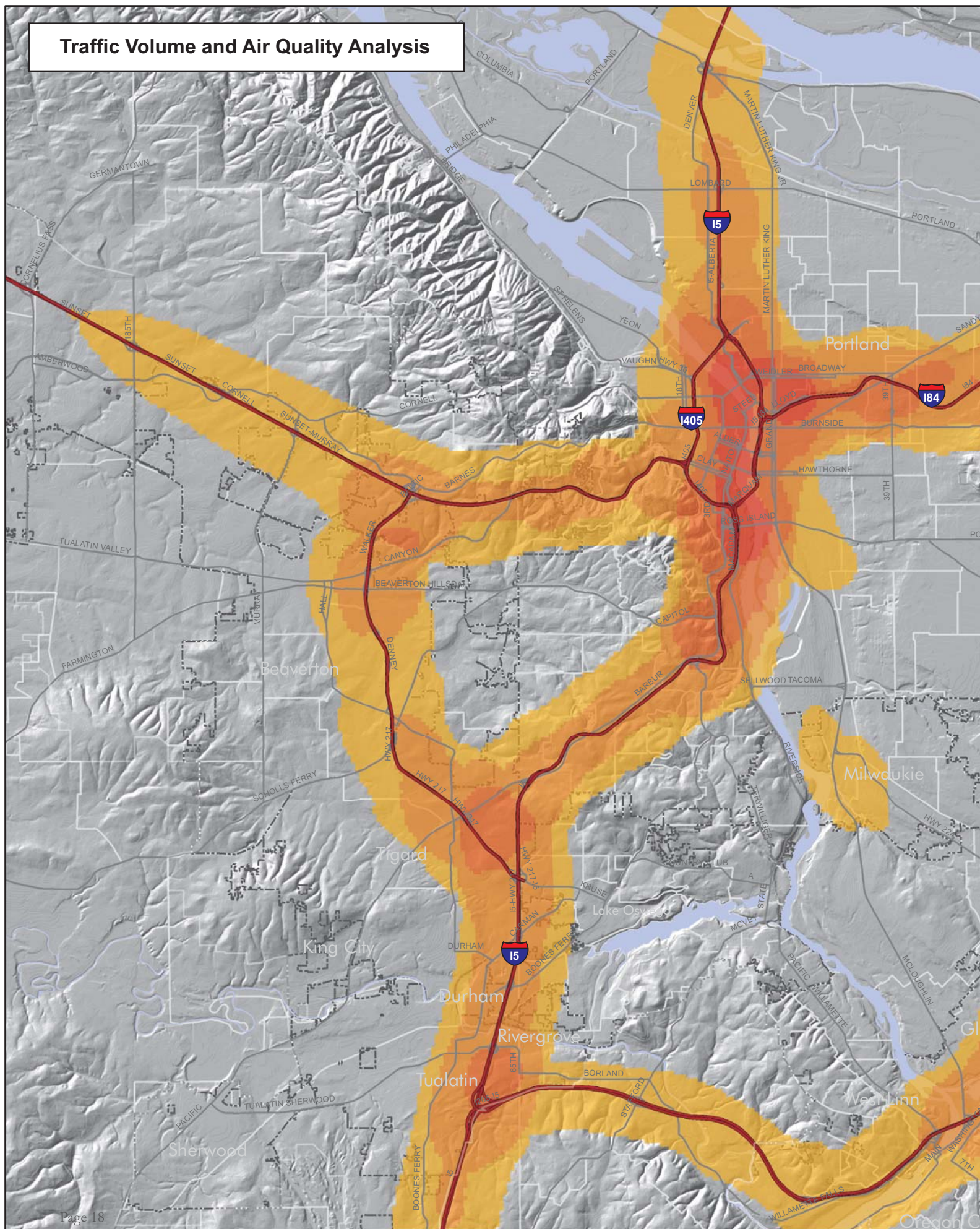
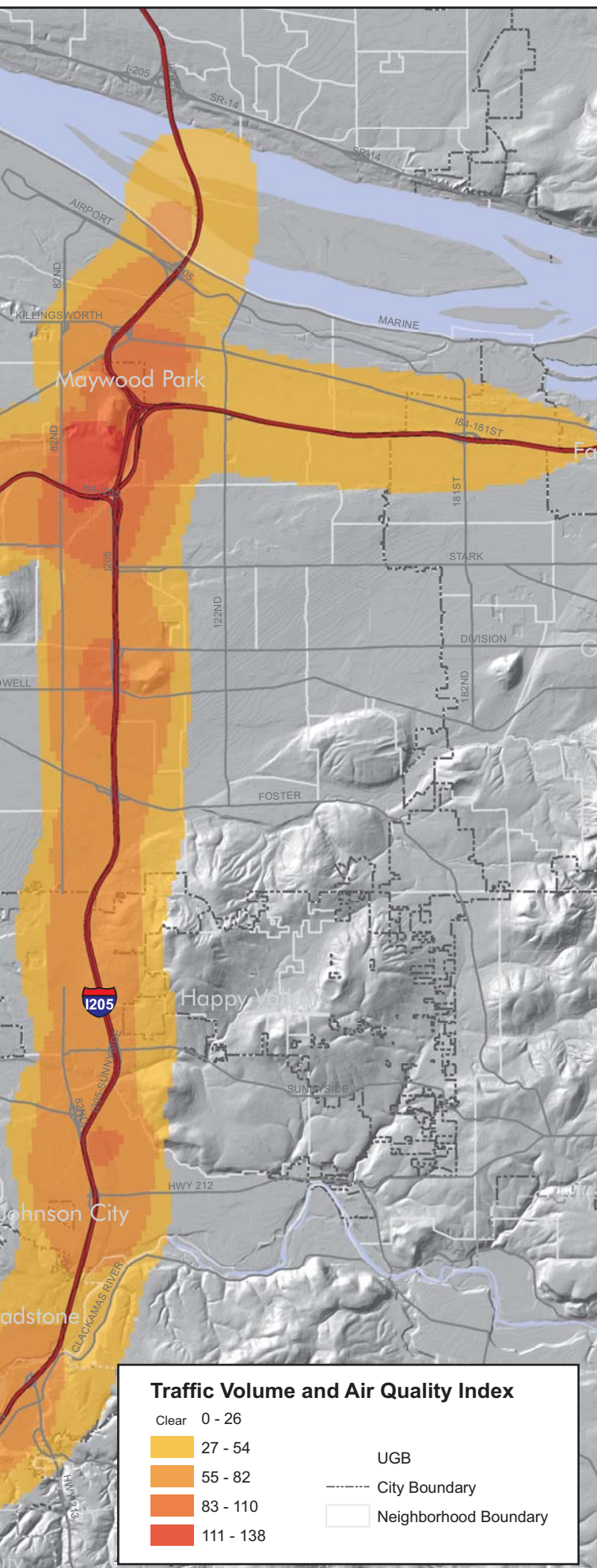


Figure 7



Sources: DEQ, ODOT

Towards Cleaner Air

How does new and better information affect our decision making? In the case of regional air quality, we are getting a clearer sense for how concentrations of different pollutants vary around the region. While it may be premature to think that cars, trucks, and boats will improve the pollutants in their exhaust any time soon, in the short term, these variations suggest that communities in our region are disproportionately affected by poor air quality. For example, some individuals may be able to choose where they live or work based on environmental quality. Many others may not be able to choose where they live because their financial or social conditions constrain them to live and work in highly polluted areas. Such examples illustrate that individual choice is only one part of a larger social landscape that affects communities and individuals. If this new information about air quality does not benefit society equally, then what are other options for improving the quality of life for all metroscap residents?

One option may be to think about the connections between health, planning, and public policy. Several urban areas, including our own region, have started to look more closely at ways that public health and planning can work together to achieve more sustainable urban forms. One result is the creation of tools, such as health impact assessment, that allow for planning and public health agencies to examine how specific decisions will affect human health. To assist in these efforts, researchers are developing techniques to assist decision makers in thinking about human health impacts of planning decisions. By drawing on traffic volume data and PATA, we are able to assess the importance of automobile traffic in creating high concentrations of toxic air pollutants. Although several factors interact to affect air quality, Figure 7 illustrates the extent to which air quality is affected by freeway traffic volume. Those areas in red, orange, and yellow show a strong connection between air quality and traffic, while the areas in green are less linked to automobile traffic. As a result, we can use this simplified analysis to rapidly assess the effect of roadways and traffic intensity on urban air quality.

The air we breathe affects our ability to live. Throughout the early 1900s the fields of public health and planning were working together to improve the conditions of people living in urban areas. Over the past several decades, the two fields have slowly drifted apart in their management responsibilities. New information such as the PATA results suggest an urgency for linking the two fields in order to achieve a collaborative public policy that can improve the quality of life for all residents.

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